

Yellow nutsedge (*Cyperus esculentus*) control with metham-sodium in transplanted cantaloupe (*Cucumis melo*)

W.C. Johnson III*, B.G. Mullinix Jr.

Research Agron., USDA-ARS and Agric. Res. Statistician, Coastal Plain Exp. Sta., Tifton, Ga 31793-0748, USA

Received 21 August 2006; accepted 21 August 2006

Abstract

Irrigated field trials were conducted from 2001 to 2003 in Tifton, Georgia at the Coastal Plain Experiment Station to determine the optimum combination of pre-plant fumigation interval, metham-sodium dose, and seedbed mulching for yellow nutsedge control in transplanted cantaloupe. The trial evaluated all possible combinations of pre-plant fumigation intervals (1-wk, 2-wk, or 3-wk before transplanting), three metham-sodium doses (nontreated, 374, and 748 l/ha), and seedbed mulching (bareground or black polyethylene mulched seedbeds). Metham-sodium sprayed and soil incorporated at 374 and 748 l/ha effectively controlled yellow nutsedge when seedbeds were covered by black polyethylene mulch, with minimal fumigant phytotoxicity. In contrast, yellow nutsedge control from metham-sodium was reduced when seedbeds were not mulched. Cantaloupe treated either 1-wk or 2-wk before transplanting with metham-sodium at 748 l/ha yielded greater than other treatment combinations. Black polyethylene mulch increased cantaloupe yield when averaged across all possible combinations of pre-plant fumigation intervals and metham-sodium doses, due primarily to improved yellow nutsedge control over bareground seedbeds.

Published by Elsevier Ltd.

Keywords: Metham-sodium; Methyl bromide alternatives; Yellow nutsedge

1. Introduction

Cucurbit crops grown in the southeastern US are typically transplanted on polyethylene covered seedbeds and much of the acreage is pre-plant fumigated with methyl bromide (Doherty and Mizelle, 2001). Used in this fashion, methyl bromide controls an array of plant pests, including weeds. The major group of weeds targeted by methyl bromide fumigation are yellow nutsedge (*Cyperus esculentus* L.) and purple nutsedge (*Cyperus rotundus* L.) (Locascio et al., 1997). Uncontrolled perennial nutsedges can pierce and emerge through black polyethylene mulch (Chase et al., 1998; Gilreath et al., 1994; Webster, 2005a, b), effectively competing with transplanted vegetable crops.

Methyl bromide (bromomethane) has been shown to deplete stratospheric ozone (Anonymous, 1998) and all uses were scheduled to be cancelled in 2005 (Noling and

Becker, 1994; USDA, 1999), with the exception of critical uses defined by the United Nations. Csinos et al. (1997, 2000) identified several alternatives to methyl bromide in vegetable crop transplant production. Their results showed that metham-sodium (methylcarbamodithioic acid) was equally effective as methyl bromide in controlling many cool- and warm-season weeds, including yellow nutsedge. Gilreath and Santos (2004) showed that metham-sodium at 945 L/ha effectively controlled purple nutsedge in spring-transplanted bell pepper (*Capsicum frutescens* L.) and improved yield compared to methyl bromide, with metham-sodium sprayed and soil-incorporated. Johnson and Webster (2001) modified a power-tiller, designed specifically for metham-sodium application, and successfully used the implement as part of a total weed management system in transplanted cantaloupe (*Cucumis melo* L.) and watermelon [*Citrullus lanatus* (Thunb.) Mansf.] (Johnson and Mullinix, 2002).

While metham-sodium has been shown to be an acceptable weed control replacement for methyl bromide, questions remain about use in the southeastern US

*Corresponding author. Tel.: +1 229 386 3172; fax: +1 229 386 3437.

E-mail address: cjohnson@tifton.usda.gov (W.C. Johnson III).

regarding doses for yellow nutsedge control, time of application, and the need for polyethylene mulch to seal the fumigant. Therefore, studies were initiated in 2001 to refine the use of metham-sodium for yellow nutsedge control in transplanted cantaloupe.

2. Materials and methods

Irrigated field trials were conducted from 2001 to 2003 at the Coastal Plain Experiment Station Ponder Farm near Tifton, GA. The soil was a Tifton loamy sand (fine-loamy, kaolinitic, thermic Plinthic Kandiudults), composed of 88% sand, 6% silt, and 6% clay, with 0.2% organic matter and pH 6.4. These sites represent commercial cantaloupe production in the southeastern US and had heavy natural infestations of yellow nutsedge (> 50 plants/m²).

The experimental design was a randomized complete block with a factorial arrangement of treatments replicated four times. Treatments included all possible combinations of pre-plant fumigation interval (3-wk, 2-wk, and 1-wk before transplanting cantaloupe), metham-sodium dose (nontreated, 374, and 747 L/ha), and seedbed mulching (bareground and black polyethylene mulch covered seedbeds).

Pre-plant fumigation intervals were based on time prior to transplanting cantaloupe, with transplanting date being the same across the entire experiment. In each case, seedbeds were freshly tilled, sprinkler irrigated (1.2 cm), and weed-free at the time of treatment. Metham-sodium was applied with a specialized power tiller specifically designed to spray metham-sodium in a 61 cm band and incorporate to a depth of 7.6 cm (Johnson and Webster, 2001). Non-diluted metham-sodium (Vapam HL[®], containing 0.51 kg/L metham-sodium. AMVAC Chemical Corp., 4100 E. Washington Blvd., Los Angeles, CA 90023) was applied in these trials. The only means to control metham-sodium dose were to change ground speed of the sprayer/tiller or alter sprayer flow-rate with nozzle-tip orifice or pressure adjustments. With these limitations, the metham-sodium calibrated dose was 748 L/ha, compared to the registered dose of 701 L/ha (Anonymous, 2005), using a ground speed of 0.9 m/s and spray pressure of 166 kPa. The 374 L/ha metham-sodium dose was achieved by increasing ground speed to 1.8 m/s. Metham-sodium doses are hitherto referred to as $\frac{1}{2}x$ and $1x$ for 374 and 748 L/ha, respectively. Black polyethylene mulch, 1 mil thick and 61 cm wide, was spread in the appropriate plots immediately after each time of metham-sodium application using a mulch layer (Pro-Junior Series[®] mulch layer, Buckeye Tractor Company, P. O. Box 123, Columbus Grove, OH 45830).

Three weeks before transplanting, 'Vienna' cantaloupe (Seminis Inc., 2700 Camino del Sol, Oxnard, CA 93030-7967) were seeded in greenhouse trays (Speedling[®] Incorporated, P. O. Box 7220, Sun City, FL 33586-7220). Each tray contained 128 cells and each cell was 3.8 × 3.8 cm in dimension. Seedlings were established in the field

using a transplanter (Kennco Manufacturing Inc., P. O. Box 1149, Ruskin, FL 33575) that simultaneously cut holes in the polyethylene mulch and transplanted seedlings in one row centered on the finished seedbed. Cantaloupe were transplanted into the field on 4 May 2001, 29 April 2002, and 3 June 2003. Plots were 1.8 m wide and 6.1 m long, with cantaloupe seedlings spaced 56 cm apart. Plots were sprinkler irrigated as needed, based on crop and meteorological conditions. Ethalfluralin (0.6 kg ai/ha) plus glyphosate (1.1 kg ai/ha) were applied to the entire experiment after transplanting for maintenance weed control in the row middles using a hooded sprayer that treated a band 71 cm wide. Excluding weed control, cultural practices and pest management decisions for transplanted cantaloupe were based on recommendations from the Georgia Cooperative Extension Service (Boyhan et al., 1999).

Visual estimations of yellow nutsedge control and crop injury were taken early-season (3 wk after transplanting) each year on a scale of 0–100 (compared with the nontreated control, where 0 = no weed control or crop injury and 100 = complete weed control or crop injury). Visual estimates of yellow nutsedge control were based on the presence of yellow nutsedge in the finished seedbed, including yellow nutsedge emerging through the polyethylene mulch and present in transplant hole. Yields were measured by harvesting mature fruits from the entire plot at four-day intervals, depending on the continued presence of marketable fruits.

Data were analyzed using a mixed-model analysis. Degrees of freedom were partitioned to test singularly and in combination the effects of time of treatment, metham-sodium dose, and seedbed mulching on yellow nutsedge control, visual injury, and cantaloupe yield. Means were separated using Fisher's Protected LSD ($P \leq 0.05$).

3. Results

Data analysis showed nonsignificant year effect for all parameters. Therefore, all data are pooled across years.

3.1. Yellow nutsedge control

Over the three year term of this experiment, yellow nutsedge control was not affected by pre-plant fumigation interval (data not shown). However, yellow nutsedge control was affected by interactive effects of metham-sodium dose and seedbed mulching (Table 1). Metham-sodium at the $\frac{1}{2}x$ and $1x$ doses controlled yellow nutsedge 84–85%, respectively, when seedbeds were covered with black polyethylene mulch. However, on bareground seedbeds the $1x$ dose of metham-sodium was more effective (75%) in controlling yellow nutsedge than metham-sodium at the $\frac{1}{2}x$ dose (59%). Interestingly, the $\frac{1}{2}x$ dose of metham-sodium with polyethylene mulch covered seedbeds controlled yellow nutsedge 84% compared 75% control from the $1x$ dose on bareground seedbeds, showing the

Table 1

Effect of seedbed mulching and metham-sodium dose on yellow nutsedge control in transplanted cantaloupe; Tifton, GA, 2001–2003^a

Seedbed mulching	Metham-sodium dose ^b	Yellow nutsedge control (%)
Polyethylene covered seedbeds	Nontreated	74
	Metham-sodium ($\frac{1}{2}x$)	84
	Metham-sodium (1x)	85
Bareground seedbeds	Nontreated	8
	Metham-sodium ($\frac{1}{2}x$)	59
	Metham-sodium (1x)	75
LSD (0.05)		11

^aAll data are averaged across years and time of metham-sodium fumigation.

^bNon-diluted metham-sodium applied with a modified power-tiller and sprayer. Doses: ($\frac{1}{2}x$), 374 L/ha; 1x, 748 L/ha. Registered use dose for metham-sodium is 700 L/ha. Sprayer calibration was achieved by altering ground speed. The limited ability to calibrate application equipment spraying non-diluted metham-sodium resulted in slightly different doses from those registered.

importance of black polyethylene mulch in metham-sodium efficacy on yellow nutsedge.

3.2. Cantaloupe injury

Visual injury was not affected by seedbed mulching (data not shown). However, the interactive effects of pre-plant fumigation interval and metham-sodium dose affected cantaloupe injury (Table 2), although there was very little visual injury from metham-sodium during this three year study.

3.3. Cantaloupe yield

Total cantaloupe yield was affected by the interactive effects of pre-plant fumigation interval and metham-sodium dose. Maximum cantaloupe yields were in plots with 1x dose of metham-sodium applied either 1-wk or 2-wk before transplanting, which were also among the most efficacious treatment combinations on yellow nutsedge (Table 2). The lowest cantaloupe yields of all treatments evaluated were generally in the non-treated controls.

4. Discussion

4.1. Yellow nutsedge control

These data show that yellow nutsedge was effectively controlled with metham-sodium when treated seedbeds are covered with black polyethylene mulch. Results from earlier studies suggest that dose, application method, and seedbed coverage affects weed control efficacy with metham-sodium. For example, Gilreath et al. (1994)

Table 2

Effect of time of fumigation and metham-sodium dose on cantaloupe injury and total yield; Tifton, GA, 2001–2003^a

Time of fumigation	Metham-sodium dose ^b	Visual injury (%)	Total yield (no./ha)
3-wk pre-transplant	Nontreated	0	9860
	Metham-sodium ($\frac{1}{2}x$)	3.6	12,380
	Metham-sodium (1x)	0.7	11,770
2-wk pre-transplant	Nontreated	0	11,100
	Metham-sodium ($\frac{1}{2}x$)	0	13,620
	Metham-sodium (1x)	0.4	15,970
1-wk pre-transplant	Nontreated	0	12,050
	Metham-sodium ($\frac{1}{2}x$)	1.1	11,380
	Metham-sodium (1x)	1.8	16,310
LSD (0.05)		1.4	1950

^aAll data are averaged across years and seedbed mulching.

^bNon-diluted metham-sodium applied with a modified power-tiller and sprayer. Doses: ($\frac{1}{2}x$), 374 L/ha; 1x, 748 L/ha. Registered use dose for metham-sodium is 700 L/ha. Sprayer calibration was achieved by altering ground speed. The limited ability to calibrate application equipment spraying non-diluted metham-sodium resulted in slightly different doses from those registered.

soil-injected metham-sodium to spring transplanted pepper (*Capsicum* spp.) and the resulting purple nutsedge control was poor. In the same trial, metham-sodium was sprayed and incorporated with a power-tiller to fall-seeded cucumber (*Cucumis sativus* L.) and purple nutsedge control was excellent. Purple nutsedge was also effectively controlled in later trials where metham-sodium was sprayed and incorporated with a power-tiller (Gilreath and Santos, 2004). However, the metham-sodium dose evaluated was 945 L/ha compared to the registered dose of 701 L/ha (Anonymous, 2005). Locascio et al. (1997) reported poor (32–56%) control of purple nutsedge with sprayed and incorporated metham-sodium at 300 L/ha. Metham-sodium sprayed at a full-dose and incorporated did not effectively control purple nutsedge in turfgrass sod production (Unruh et al., 2002). However, the seedbed in this trial was sealed with a soil-roller after treatment and not covered with polyethylene mulch. These results show that successful control of purple nutsedge using metham-sodium requires the fumigant to be sprayed at the full dose, soil incorporated, and seedbeds covered with polyethylene mulch. Our results show that the same techniques will allow effective control of yellow nutsedge with metham-sodium.

Black polyethylene mulch suppressed yellow nutsedge in our trials. Yellow nutsedge control in nontreated plots covered with polyethylene mulch was 74%, which was similar to 75% control on bareground seedbeds treated with the 1x dose of metham-sodium (Table 1). Previous studies have demonstrated that yellow nutsedge is capable of penetrating opaque mulches (Chase et al., 1998; Gilreath

Table 3
Effect of seedbed mulching on cantaloupe yield; Tifton, GA, 2001–2003^a

	1st harvest	2nd harvest	3rd harvest	4th harvest (no./ha)	5th harvest	6th harvest	Total harvest
Polyethylene covered seedbeds	3670	3450	3700	1720	970	750	14,260
Bareground seedbeds	2030	3490	2850	1660	550	600	11,180
LSD (0.05)	1130	ns	660	ns	390	ns	1050

^aAll data are averaged across years, time of fumigation, and metham-sodium doses.

et al., 1994; Webster 2005a,b), yet >89% of emerged yellow nutsedge shoots remain trapped beneath black polyethylene mulch (Majek and Neary, 1991; Webster, 2005a). These results suggest that the partial suppression of yellow nutsedge emergence by black polyethylene mulch may be a useful tool in an integrated yellow nutsedge management system in transplanted cucurbit crops.

An additional observation was made in nontreated plots covered with black polyethylene mulch. Early-season yellow nutsedge control was 84% in nontreated plots using black polyethylene mulch applied within 1-wk of transplanting, which was similar to the 86% nutsedge control from covered plots treated with the 1x dose of metham-sodium at the same pre-plant fumigation interval (data not shown). In contrast, yellow nutsedge control in nontreated plots was 72% and 65% when black polyethylene mulch was applied 2-wk and 3-wk before transplanting, respectively. Transplanting a rapidly growing, aggressively vining cucurbit crop like cantaloupe soon after applying polyethylene mulch gives cantaloupe the opportunity to cover the seedbed before yellow nutsedge emergence through black polyethylene mulch. This could be of significant value in cropping systems where fumigation or herbicide treatment is not possible, such as organic crop production.

4.2. Cantaloupe injury

Visual stunting from metham-sodium ranged from 0% to 3.6% (Table 2), which is inconsequential. Cantaloupe were transplanted 4 May 2001, 29 April 2002, and 3 June 2003, which is three to eight weeks later than normal for the region. It is possible that the resulting warmer soil conditions may have allowed metham-sodium to dissipate quicker than if applied to cool soils earlier in the season. This may have lessened the chances for metham-sodium phytotoxicity on cantaloupe at the 1-wk and 2-wk applications.

4.3. Cantaloupe yield

When cantaloupe yields at individual harvest dates were considered, seedbed mulching was the only treatment variable of significance (Table 3). When averaged over times of fumigation and metham-sodium doses, black polyethylene mulch increased transplanted cantaloupe yield an average of 28% over production on bareground

seedbeds in three of six harvest dates and total yield. Bonanno and Lamont (1987) reported greater muskmelon (*C. melo*) yield in North Carolina from polyethylene mulched seedbeds compared to bareground. They attributed the yield increase to the polyethylene mulch warming the seedbed when average temperatures were nearly normal for the location. However, there was no yield difference when average temperatures were higher than normal, negating the soil warming advantages of polyethylene mulch. In our trials, cantaloupe were transplanted later than normal for the region and temperatures were correspondingly warmer compared to normal transplanting dates. Therefore, we believe that the 28% yield increase in our trials from seedbed mulching was not due to warmer soil temperatures in mulched plots, but due to overall better yellow nutsedge control in mulched seedbeds compared to bareground seedbeds (Table 1).

5. Conclusion

These data show the value of metham-sodium and black polyethylene mulch as tools in an integrated yellow nutsedge management system in transplanted cantaloupe. Superior yellow nutsedge control and cantaloupe yield performance is provided by a 1x dose of metham-sodium sprayed and incorporated with a power-tiller, with seedbeds covered with black polyethylene mulch. Using this treatment combination, metham-sodium applied 1-wk or 2-wk before transplanting effectively controlled yellow nutsedge, was not overly injurious to cantaloupe, and provided the greatest cantaloupe yield of all treatment combinations. The metham-sodium registration does not allow for crop seeding/transplanting earlier than 3-wk after treatment due to potential for crop injury (Anonymous, 2005). However, these data suggest that the registration can possibly be modified for earlier applications in temperate regions than those currently allowed, adding flexibility to metham-sodium use in transplanted cantaloupe.

Acknowledgments

This research was supported by a grant from the Georgia Fruit and Vegetable Growers Association. We acknowledge the technical contributions of Daniel R. Evarts and Vann M. Jones in these trials. Mr. Evarts was solely

responsible for the design and construction of specialized equipment used for herbicide application in these trials, along with overall field operations. Seminis Inc. generously provided the hybrid cantaloupe seeds used in these trials.

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